

PALYNOLOGY AND RADIOCARBON CHRONOLOGY OF BATTAGLIA BOG, PORTAGE COUNTY, OHIO¹

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The Battaglia Bog, Portage County, Ohio has deposits spanning the time from about 16,500 B.P. to an estimated 6000 B.P., with good pollen records covering approximately 16,500 to 9000 B.P. The pollen deposits represent Zone I, the basal spruce-fir zone, and Zone II, the pine maximum, with subsequent deposits having been destroyed by agriculture. Local vegetation deposits show a shift from a cold water oligotrophic lake to a shallow basin, rapidly filling with *Sphagnum* and then with ferns. Three radiocarbon dates from the site present a clear sequence: Zone I-A (16,500-13,600 B.P.) shows high spruce percentages and a cold water oligotrophic lake; Zone I-B shows reduced spruce percentages, increasing deciduous arboreal pollen, plus lake shallowing; Zone II (11,000-9000 B.P.) shows the pine maximum and a rapidly filling basin. The basal date is probably retreat of the ice associated with the Lavery Till, so that the basal radiocarbon date of 15,570 \pm 340 B.P. may provide a minimal date for melting of this glacial feature.

The use of pollen analysis in conjunction with radiocarbon chronology has become an established tool in the reconstruction of past climatic and vegetational history and in dating geological deposits. Although about forty pollen studies have been done in Ohio (Shane, 1974), only three have been published in detail since the early 1950's (Kapp and Gooding, 1964; Ogden, 1966; Garrison, 1967). This paper presents the results of a study from the Battaglia Bog in Portage County, northeast Ohio. (fig. 1).

MATERIALS AND METHODS

The Battaglia Bog (technically a fen) is located on the east side of Kent, Portage County, Ohio on land belonging to Mr. Paul Battaglia (N 41° 08' 38"; W 81° 19' 43"). It is oval with a drainage pattern similar to kettle lake type 35 (Hutchinson, 1957). The site was tiled and drained in the 1930's and subsequently used for agriculture, so pollen in the top meter is not preserved. Local vegetation is typical of highly disturbed areas and is not relevant to this study, because the pollen record is truncated at about 9,000 B.P.

Cores were taken in the fall of 1969 with a Hiller borer and in the fall of 1973 with a Livingstone piston sampler from adjacent locations in the deepest part of the deposit. Two percentage diagrams were prepared from the 1969 core. Samples from the 1973 core provided a very similar diagram, allowing correlation of the two cores. Radiocarbon determinations were done on the 1973 core by the Illinois State Geological Survey.

Samples were prepared by modified standard methods (Faegri and Iverson, 1964) including treatment with 10% KOH, screening, 10% HCl, HF (samples below 325 cm), acetolysis, and mounting unstained in glycerine jelly. Complete slides were scanned at 100 \times and identifications were made at 430 \times . Scanning continued until either a count of 200+ grains was obtained or all ten slides for the level were completed. *Lycopodium* tablets (Stockmarr, 1971) were used for pollen influx studies on the 1973 core.



FIGURE 1. Ohio: Glacial features and palynological sites. 1. Carter Site (Shane, in progress); 2. Sunbeam Prairie (Kapp and Gooding, 1964); 3. Silver Lake (Ogden, 1966); 4. Refugee Road (Garrison, 1967); 5. Battaglia Bog.

RESULTS AND DISCUSSION

The data from this site pertain to (1) the age of the deposits and their sig-

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nificance for glacial retreat chronology, and (2) the vegetational changes shown and their relation to other Ohio studies.

Glacial Chronology. Four major till sheets of the Late Wisconsin glaciation associated with two glacial lobes described for northeast Ohio are shown in figure 2 (Goldthwait, *et al.*, 1965; Winslow

of the site. The resulting interlobate area, where heavy drainage must have taken place, runs north from the southwest corner of Portage County into Geauga County. Battaglia bog is within this area. Research done in the 1950's (Winslow and White, 1966) shows surface deposits of Kent Till, suggesting

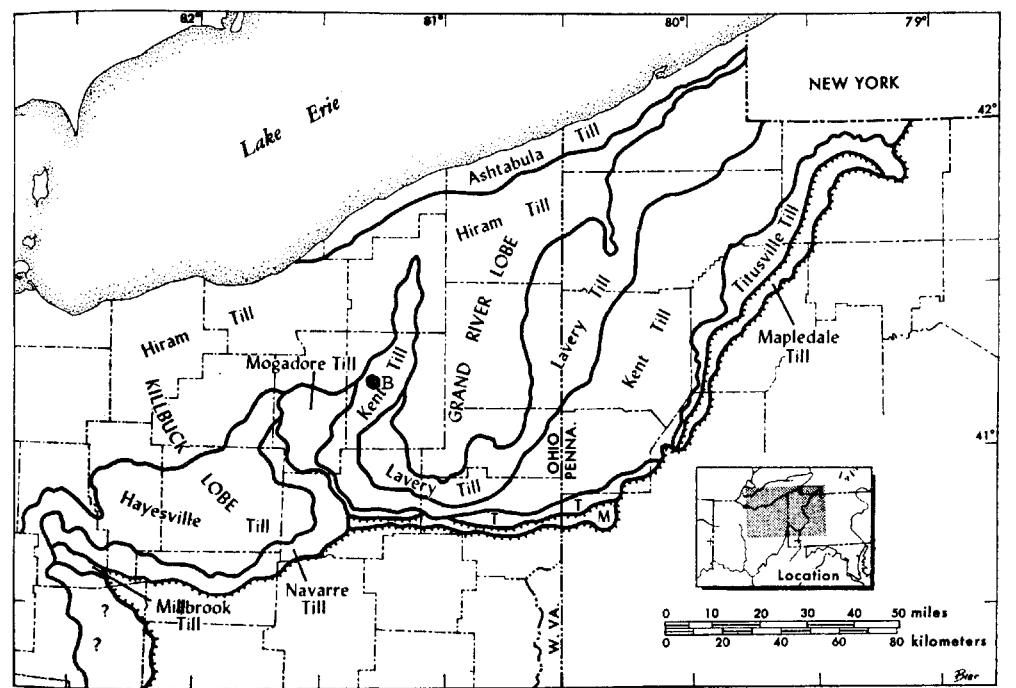


FIGURE 2. Till sheets of the Allegheny Plateau. B=Battaglia Bog. (From White, 1969, p. 133 with permission).

and White, 1966; White, 1969). The names and estimated dates of these tills are shown in table 1. The Grand River and Killbuck lobes are bifurcated by a topographic high about 25 miles north

that the features in the interlobate area are older than the neighboring land surfaces. However, subsequent work has shown that the Kent Till is not as thick as originally thought but is rather a thin, fully weathered layer above the more massive pre-Plum Point interstade Titusville Till. Furthermore, the younger Lavery Till is thin in many places and more extensive than originally described (White, Totten, and Gross, 1969; White, 1969; White, personal communication). There are deposits of Lavery Till (not shown on fig. 2) within a mile north, and new roadcuts to the south have also exposed this deposit (White, personal communication).

It is probable that Battaglia basin is

TABLE 1 Chronology of Late Wisconsin Till sheets of northeast Ohio. (Estimated ages from Goldthwait et al., 1965)		
Killbuck Lobe	Grand River Lobe	Estimated age B.P.
Ashtabula Till	Ashtabula Till	13,000
Hiram Till	Hiram Till	14,500
Hayesville Till	Lavery Till	16,500
Kent Till	Kent Till	21,000?

in Lavery Till rather than Kent Till, so the basal radiocarbon date of $15,570 \pm 340$ B.P. is significant as a minimal time for retreat of the Lavery ice. However, the sample is 20 cm long with another 25 to 35 cm of gyttja below it and above the basal sand. This adds approximately 40 cm which may represent between 600 and 1100 years of deposition. The former figure is based on a calculated sedimentation rate 6.5 cm/100 years, using a separation of 125 cm and 1,930 years between the basal sample and the 300 cm radiocarbon sample. The latter figure is based on a sedimentation rate of about 3.6 cm/100 years reported in pre-10,000 B.P. levels by Ogden (1967b) and Davis (1967) for sites in Ohio and New England. Williams (1974) observed similar rates in Indiana. Thus the estimated time for initiation of deposition (16,200 to 16,700 B.P.) is very close to the 16,500 B.P. time of Lavery Till illustrated in Goldthwait *et al.* (1965). The only other date associated with Lavery Till is from a bog in Pennsylvania where Lavery Till was later discovered to overlie Kent Till (White, Totten, and Gross, 1969). The oldest date from this site is $14,000 \pm 350$ B.P., but cannot be compared directly to the Battaglia sample, because the Pennsylvania sample was taken from the marl above the basal clays and nine feet above the basal sand (Droste, Rubin, and White, 1959).

In the original description of the Battaglia study (Shane, 1972), it was estimated that deposits began after the retreat of Kent ice because the extent of the overlying Lavery Till area was not clear. However, correlation with the Lavery

Till generates the problem that little if any time is allowed for melting of the ice-block that formed the basin. Florin and Wright (1969) for Minnesota, Mickelson and Born (1972) for Maine, and Williams (1974) for Indiana give evidence that a delay of 1000–3000 years is possible between separation of dead ice and melting that leads to full development of a depositional basin. This may have happened at Silver Lake, Logan County, Ohio where the estimated ice-free date of about 16,000 B.P. is earlier than Ogden's (1966) estimate of 14,000 B.P. for basal deposits. If the Battaglia basin formed from a Kent ice remnant 1000 to 3000 years prior to initiation of deposition, (17,000 to 19,000 B.P.) this would correlate with retreat time of ice that deposited the surface of the Cuba and Hartwell moraines in western Ohio (Goldthwait, *et al.*, 1965). However, lack of sufficient dated deposits and absence of kettle ice melt studies from Ohio leave this to speculation. At present, association with the Lavery Till and a date of 16,200 to 16,600 B.P. for initiation of deposition best fit the data.

Vegetational History and Inferred Climatic Change. Sears (1942) and Ogden (1966) defined classic zones for Ohio pollen diagrams (table 2). The Battaglia sequence covers only the basal portion of this pattern (Zones I and II) but is of interest because it is older than most Ohio diagrams which come from areas that have been ice-free for 14,000 years or less (Potter, 1947).

Two diagrams have been prepared. Diagram I (fig. 3) shows the regional vegetation including arboreal pollen (AP)

TABLE 2
Post-glacial pollen zones of Ohio.

Sears (1942)	Ogden (1966)	Climatic interpretation	Indicator vegetation
—	3d	as present	sharp rise in <i>Ambrosia</i>
V	3c	cooler, moister than previous zone	present forest
IV	3b	warm, dry	oak-hickory maximum; beech minimum
III	3a	warm, more humid than previous zone	deciduous forest; beech maximum
II	2	dry, warmer than previous zone	pine maximum; some oak
I	1	cold to cool, moist	spruce-fir maximum

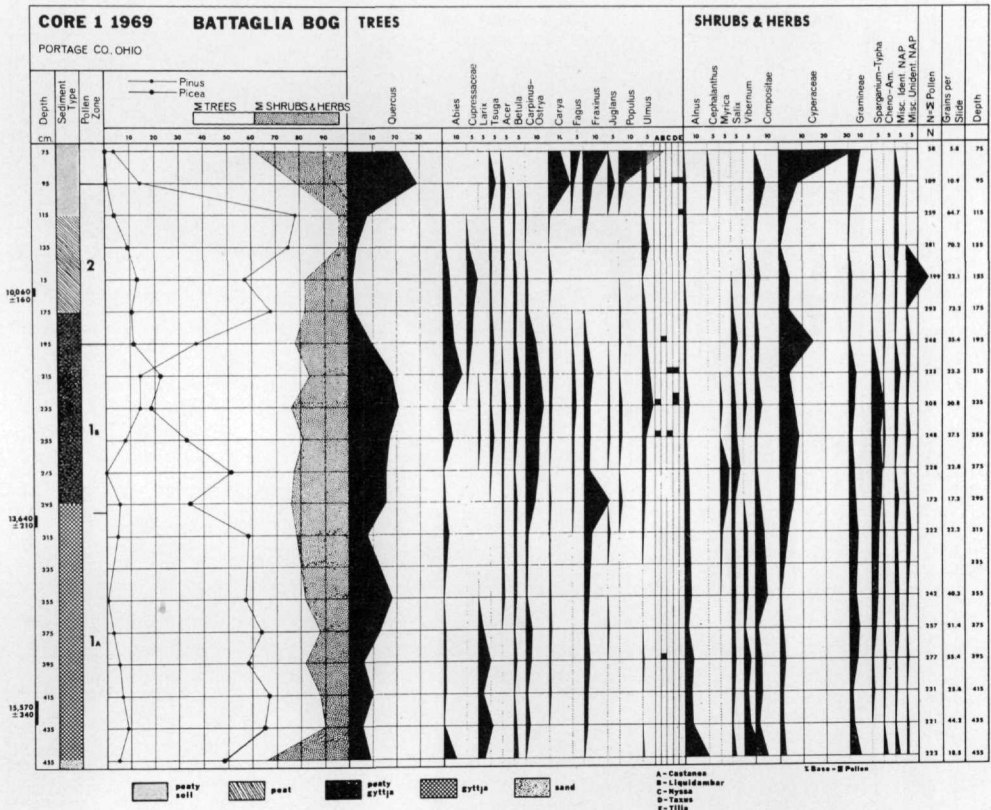


FIGURE 3. Diagram I. Battaglia Bog; regional arboreal and non-arboreal pollen.

and some non-arboreal pollen (NAP). Diagram II (fig. 4) shows locally deposited NAP and certain non-pollen microfossils (NPM). Because of the relatively greater age of the deposit, Zone I has been divided into parts A and B. Zone II is clear and the shift to Zone III is marginally distinguishable. Dates given are estimated accurate to about ± 250 years.

Zone I-A.—(455 to 300 cm; 16,500 to 13,600 B.P.). This segment covers the first stage of retreat of the last large ice advance of the Late Wisconsin. The percentage diagram gives no evidence of tundra in the deepest deposits, and preliminary pollen influx measurements confirm this. Both Graminae and Cyperaceae are well below 10% while *Picea* is well above 50%, with minor percentages of other tree genera. Since the site is within 30 miles of the southern glacial margin in northwest Ohio, it is not ex-

pected that any level would be completely free of arboreal pollen. The dominance of *Picea* and the presence of *Abies* clearly indicate cool to cold climate. Diagram II shows the presence of low but constant amounts of lake margin plants of the *Sparganium-Typha* type. The abundance of wind-borne pollen with the low level of lake margin plants is interpreted to represent a small cold-water oligotrophic lake.

Zone I-B.—(300 to 195 cm; 13,600 to 11,000 B.P.). These deposits show a marked shift away from cold environments and a slow but steady increase in diversity and numbers of temperate deciduous genera. The changes that mark this shift are: (1) marked increase in siliceous material in sediment below 295 cm; (2) major fluctuations in both *Picea* and *Fraxinus* curves; (3) general increase in diversity of types; (4) indications from Diagram II that the lake

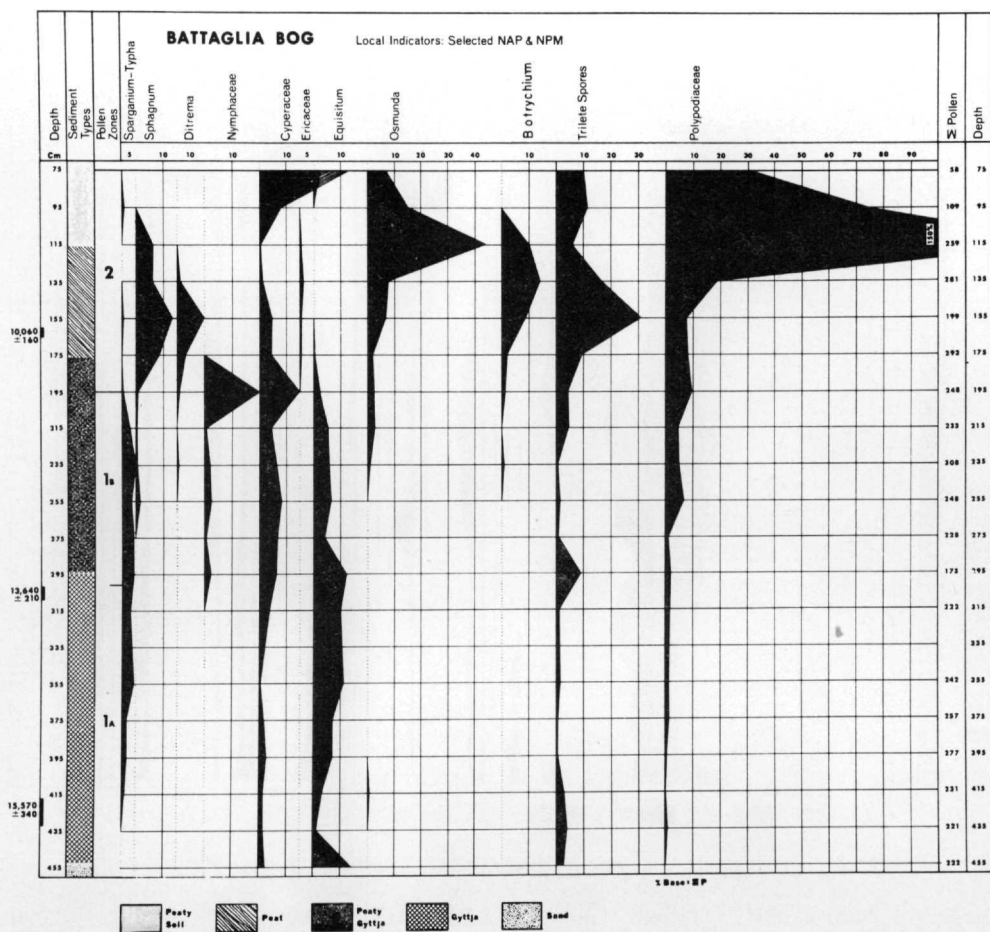


FIGURE 4. Diagram II. Battaglia Bog: selected local non-arboreal pollen and non-pollen micro-fossils.

was becoming warmer and more shallow as marked by the first appearance of Nymphaeaceae. Thus a picture of warming environments and a filling lake are characteristic of this level. The radiocarbon date of $13,640 \pm 210$ B.P. at the I-A to I-B transition is clearly in sequence with those above and below, and is close to the 14,000 B.P. date originally estimated. Ohio pollen diagrams from areas deglaciated since 14,000 B.P. show reducing *Picea* percentages (Potter, 1947) as in Zone I-B with no prolonged high *Picea* percentages as in Zone I-A.

Zone II.—(195 to 95 cm; 11,000 to estimated 9,000 B.P.) This level is characterized by a maximum in *Pinus* pollen. The interpretation vegetationally and climatically of the "pine maximum"

which is a common feature in northeastern United States diagrams is still under discussion in terms of its duration and the extent of *Pinus* distribution. The abundance and buoyancy of pine pollen leading to over-representation in deposits (Davis, 1963) complicates this picture. Information from absolute pollen diagrams (Davis, 1967) and from a survey of radiocarbon dated sites (Ogden, 1967a) would suggest that this is a chronologically localized period of about 1000 years or less in duration in any one area and dated at about 10,000 B.P. The radiocarbon date of $10,060 \pm 160$ from this Battaglia zone fits well with this pattern. Indications seem clear for a fairly sudden climate change. This change in Ohio was probably one of in-

creased drying that accentuated the continuing warming trend associated with retreat of the glacial ice. Terasmae (1968) suggests that in Ontario prior to 10,000 B.P., *Picea* forests were in muskegs which in marginal areas could dry up very rapidly with a slight shift to warmer, drier conditions. To the southwest in Ohio, Sunbeam Prairie (Kapp and Gooding, 1964) and Carter site (Shane, in progress) both in Darke County, and Refugee Road (Garrison, 1967) in Franklin County are all truncated, presumably by dessication, immediately below the Pine maximum. Bryson and Wendland (1967) in a reconstruction of airflow patterns over North America during late and post-glacial times propose a drying mechanism and suggest that especially on slopes and south-facing locations, *Picea* would be eliminated. An obvious candidate for opened dry areas would be *Pinus*. Ogden (1966) feels that at the time of the pine maximum there was more open area around Silver Lake. *Pinus* would have a brief advantage before the longlived hardwoods moved in. In spruce-fir forest management today, it is essential to prevent overclearing in areas where hardwood and spruce-fir forest intermingle to prevent a hardwood succession that is almost irreversible. (Westveld, 1953). A plausible sequence for the pine maximum is: Wet areas with *Picea* concentrations; *Picea* eliminated by rapid warming and drying climate shifts that result in more open country and an increase in *Pinus* in scattered suitable niches, probably without the development of extensive pine forest; rapid hardwood succession.

Local warming and drying is suggested by the data from Battaglia. Diagram II shows a clear pattern of shallow water developing with a maximum of Nymphaeaceae followed by a rapid and parallel growth of *Sphagnum* and *Ditrema* (a *Sphagnum* parasite). This is climaxed by massive deposits of fern spores, almost to the exclusion of other plants. Whether the rapid filling began because of reduced water levels or because warmth accelerated plant growth, or both is not clear, but the pattern of warmer, drier conditions is evident.

Zone III.—(95 cm to surface). The

pollen record of this zone is almost completely destroyed by the plowing and draining of the site. Pollen counts are too low to be used, but an increase of deciduous trees above zone II is suggested. It is not known when filling stopped, but it is possible that this dates from around 6000 B.P. when Lake Erie (Hough, 1958) and presumably all area water tables were lower (McComas, personal communication).

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